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The Longevity of Starved Cockroaches[1]

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Under normal conditions, cockroaches find adequate food and water in their environment for survival and reproduction. Under less favorable circumstances, such as when they spread into other areas through ordinary commercial channels, cockroaches may not find food and water readily available. DeLong (1948) has pointed out that cockroaches are commonly transported in crates of citrus fruits, banana boxes, cases of bottled beverages, paper packages of coffee beans, cartons of jellies, cartons of packaged cereals, and occasionally in packaged cigarettes. Although certain of these articles might provide dry solid food, water is lacking in most of them. Nelson (1952) has stated that, under difficult conditions, cockroaches can survive without water, subsisting only on packing case glue such as that used in boxes of canned goods. It is evident, then, that the dissemination of cockroaches over long distances or periods of time will depend to some extent on the ability of the insects to withstand starvation or desiccation.

There is relatively little information on the ability of cockroaches to survive under conditions of partial or complete starvation. For this reason, we have determined the longevity, on restricted diets, of adult cockroaches of the following species: *Blatta orientalis* L., *Blattella germanica* (L.), *Blattella vaga* Hebard, *Diploptera punctata* (Eschschultz), *Eurycotis floridana* (Walker), *Leucophaea maderae* (F.), *Nauphoeta cinerea* (Olivier), *Neostylopyga rhombifolia* (Stoll), *Periplaneta americana* (L.), *Pycnoscelus surinamensis* (L.), and *Supella supellectillium* (Serv.). Maluf (1939) listed the mean time for death during complete abstinence from food and water as 20 to 60 days for *Blatta orientalis*. He cited Sanford (1918) as the source of this information. However, we have checked Sanford's paper and have not been able to find data on survival.

METHODS.—Newly emerged adult insects were isolated in 250-ml. beakers or similar plastic containers. The bottom of each container was lined with a disc of Whatman No. 1 filter paper, and the top was covered by cloth. The insects were fed dog biscuit[3] and water for about 2 weeks before they were placed on test. After this preconditioning, the insects were placed individually on restricted diets of dry dog food only, water only, or neither food nor water. Along with these, at least 10 insects of each species were kept on dog food and water as controls. Mortality was recorded daily when possible.

The tests were run in a walk-in incubator provided with circulating, humidified air maintained at 27° C. A few tests were first run at 70% R.H., but this humidity was subsequently lowered because fungus developed on the dog food. The relative humidity during most tests was 40%, but difficulties with the control equipment during certain tests resulted in humidity variations that are indicated in table 1.

RESULTS.—The mean survival times of males and females of the 11 species of cockroaches, under the conditions of partial or complete starvation outlined above, are given in table 1. The significance of the difference between mean survival times was evaluated by means of the *t*-test. We should emphasize that the data for survival of control insects are not the adult life spans of these species; each control series was terminated after the last experimental insect of that species had died but before all the control insects had died.

It is obvious, from comparisons with the control series, that neither of the partial diets was adequate to maintain the insects for as long a time as the control insects lived on both food and water. The only exception, *Leucophaea maderae* females, will be discussed below. The survival times in 36 to 40% R.H., following complete starvation, ranged from 4.8 days for *Blattella vaga* males to about 42 days for *Periplaneta americana* females. There is a rough correlation between body size and survival under starvation conditions; the larger species, in general, survived longest. This may be partly related to differences in rates of desiccation. Gunn (1935) has shown that *Blatta orientalis* and *Periplaneta americana* lose water at about the same rate but that *Blattella germanica* has a much higher rate of water loss. Yet, in our tests, starved females of *B. orientalis* did not live significantly longer than females of *B. germanica*, but the much larger *P. americana* survived twice as long as *B. orientalis*.

In general, drinking water enabled most species to live significantly longer in 36 to 40% R.H. than did dry food alone. The only exceptions were *Blattella germanica* males, *Neostylopyga rhomibfolia*, and *Supella supellectilium*, in which survival times on dry food and on water are not significantly different. Water alone enabled most species to survive a month or more. A few false ovoviviparous species (see Roth & Willis 1955), namely *Leucophaea maderae*, *Nauphoeta cinerea* females, and *Pycnoscelus surinamensis* females, survived about 2 months on

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[2] Present address: 1199 Irving, Monterey, California.
[3] Purina Dog Chow Checkers.

Table 1.—Longevity of cockroaches on starvation diets.

Sex	Relative Humidity (%)	Mean Length of Survival ± S.E.,[a] Days: Control: Food and Water[b]	N[c]	Dry Food—No Water	N	Water No Food	N	No Food nor Water	N
				Blatta orientalis					
♀	40	64±21	11	16.8± 2.3	11	32.1±5.3	11	14.2±2.0	12
♂	40	40±10	11	11.5± 1.2	11	20.0±2.4	11	11.9±0.7	10
				Blattella germanica					
♀	40	85± 4	10	11.9± 1.5	10	41.9±2.6	10	12.8±2.0	10
♂	40	54± 3	10	8.8± 0.4	10	9.6±0.7	10	8.2±0.9	10
♀	70	79±14	6	17.5± 3.4	6	28.3±3.1	6	27.5±4.0	6
				Blattella vaga					
♀	36	95± 4	10	7.9± 0.9	10	32.4±2.6	10	8.5±0.6	10
♂	36	69±12	10	5.4± 0.9	10	10.8±2.6	10	4.8±0.3	10
				Diploptera punctata					
♀	36	102±14	10	18.7± 1.4	10	42.9±4.5	10	18.7±1.8	10
♂	36	119± 9	10	14.5± 0.8	10	28.9±2.8	10	15.8±1.0	10
				Eurycotis floridana					
♀	40	86± 6	10	26.6± 1.6	10	43.0±3.8	10	26.7±2.8	10
♂	40	70± 5	10	21.8± 1.8	10	29.7±3.0	10	21.1±3.3	10
				Leucophaea maderae					
♀	70	181±20	10	160 ±12.9	10	54.3±3.8	10	51.3±4.1	10
♂	70	150±18	10	84 ± 9.3	10	56 ±8.1	10	35.1±4.5	10
				Nauphoeta cinerea					
♀	40	98± 5	10	24.3± 2.9	11	61.1±3.8	11	27.0±1.6	10
♂	40	94± 5	10	22.8 ±3.1	13	46.1±2.4	10	27.3±1.2	10
				Neostylopyga rhombifolia					
♀	40	108±20	12	25.4± 3.9	11	26.7±4.2	11	22.1±2.8	10
♂	40	128±27	11	24.6± 3.5	11	29.3±2.1	11	21.9±3.1	11
				Periplaneta americana					
♀	36	190± 6	10	40.1± 3.0	10	89.6±4.8	10	41.7±2.7	10
♂	36	97± 0.2	10	27.3± 1.9	10	43.7±3.5	10	28.1±1.9	10
				Pycnoscelus surinamensis					
♀	40	139±12	10	18.8± 1.3	10	73.2±5.0	10	24.3±3.1	10
♂	36–40	74±11	11	9.9± 1.6	11	39.8±2.9	10	10.6±0.9	10
				Supella supellectilium					
♀	40	80± 6	10	12.8± 1.6	10	14.3±1.5	9	14.5±1.4	10
♂	40	74± 7	10	11.5± 0.8	10	10.1±1.1	10	9.0±1.2	10

[a] Standard error.
[b] These data do not indicate adult longevity as the control series were terminated before all insects died.
[c] Number of insects tested.

water only. On the other hand, *Periplaneta americana* females survived for 3 months on water alone.

There is a remarkably close similarity within each species between survival times on dry food and on no food at 36 to 40% R.H. Water obviously is a dietary necessity in cockroach survival at the lower humidities at least, and Nelson's (1952) opinion that cockroaches can survive, subsisting only on packing case glue, seems to be unsound.

The few experiments that were run in 70% R.H., with *Blattella germanica* females and with *Leucophaea maderae*, show the opposite effects that this humidity had on survival on dog food alone as compared to survival on water alone or on neither food nor water. At 70% R.H., fungus developed on the dog biscuits, and it is presumed from this occurrence that the food had picked up moisture from the air in the cockroach containers. Undoubtedly the humidity at the bottom of the cockroach containers was higher than that maintained in the incubator because of their depth and cloth covers which restricted air movement. Why these conditions were inimical to the *B. germanica* that were fed dog biscuit only, compared to those fed nothing, but favorable to *L. maderae* is not known. The dog biscuit, with the moisture it absorbed from the air at 70% R.H., was sufficient to maintain *L. maderae* females three times longer than water alone.

Dr. Jean Leclercq, Université de Liège, has kindly permitted us to cite some of his unpublished data that show the influence of atmospheric humidity on the longevity of starved *Blatta orientalis*. The data (table 2) were obtained in the winter of 1943–1944 through the use of hygrostats as described by Leclercq (1946, 1946a). Leclercq con-

Table 2.—Influence of atmospheric humidity on the longevity of starved *Blatta orientalis*.[a]

Relative Humidity (%)	Mean[b] Length of Survival ± S.E.,[b] Days: Adult Males	Number	Nymphs[c]	Number
100	11.0±3.3	15	61±10.4	8
88	10.0±3.3	15	—	—
85	—	—	25± 6.2	7
75	9.0±3.0	15	52±25.8	4
55	6.5±1.5	15	39±12.2	7
41	4.5±2.0	15	30± 6.4	7
35	4.5±3.0	15	26± 7.6	7
18	—	—	34± 7.1	4
17	4.5±3.5	15	—	—
7	—	—	17± 4.2	6
6	4.5±1.1	15	—	—

[a] Unpublished data from Leclercq (1955).
[b] We accept full responsibility for any errors in estimating the means and standard errors from a graph of data on adult males and for calculating the means and standard errors from raw data on nymphs.
[c] Third and fourth instars.

cluded that males survive as well in 6% and 17% R.H. as in 35% and 41% R.H., and that from 100% to 50% R.H. longevity diminished in a very regular fashion. He also noted that in any one humidity there was considerable variation in longevity from one specimen to another, as shown by the rather large experimental errors. With respect to the nymphs, Leclercq concluded that, in spite of insufficient statistics, young cockroaches tended to survive longer in high humidities than in low.

The presence of cockroaches wherever man is found is mute evidence of their proven ability to spread into new areas by any means available. We have attempted to find a rational basis for their survival during dispersal under less than optimum conditions. At relatively low humidities (36 to 40% R.H.), all but the smallest species can survive 2 to 3 weeks without food or water. At high humidities, or with only drinking water available, many species can survive from 1 to 3 months. Thus, it is possible for cockroaches to survive for relatively long periods in shipments of materiel that would not ordinarily be considered food. With limited access to water and solid food, cockroaches should be capable of remaining alive in cargo shipped almost anywhere in the world, subject only to extremes of temperature or insecticidal control.

SUMMARY.—The duration of survival was determined for adults of both sexes of 11 species of cockroaches under conditions of partial or complete starvation at 27° C. and 36 to 40% R.H. or 70% R.H. Following complete starvation, survival times at 36 to 40% R.H. ranged from 4.8 days for *Blattella vaga* males to 42 days for *Periplaneta americana* females; the larger species tended to survive longer than the smaller. All species, except *Leucophaea maderae* in 70% R.H., were unable to survive longer on dry food than on neither food nor water. In general, water alone enabled most species to live significantly longer in 36 to 40% R.H. than did dry food alone.

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